



**US Army Corps
of Engineers®**

Engineer Research and
Development Center

Ongoing Research

Heat and Mass Transfer in Snow

Problem

Snow and firn (snow that is more than one year old) are dynamic and complicated media, and feedbacks in heat and mass transfer mechanisms affect both the nature of the snow microstructure itself and the very processes of change. Snow microstructure plays a key role in snow and firn behavior on many scales. Often the large-scale behavior or appearance of snow is due to its small-scale properties. For example, avalanches are launched because of weak hoar layers, and remotely sensed data from satellites orbiting the planet are sensitive to snow crystal type and size.

Description

Researchers at the Engineer Research and Development Center's Cold Regions Research and Engineering Laboratory (ERDC-CRREL) in Hanover, New Hampshire, are investigating issues ranging from processes in firn for ice core interpretation to atmospheric chemistry to contaminant transport on Army lands.

ERDC-CRREL has ongoing research in heat and mass transfer in snow that ranges from the ice caps of Greenland and Antarctica to the ephemeral snow covers of the Alaskan Arctic and continental United States. This work meshes with studies on military training ranges, soil biogeochemistry, ice sheets and sea ice, atmospheric chemistry, and remote sensing of snow-covered terrain.



Sampling snow in Antarctica.

Expected Products

This research has produced and will continue to produce new knowledge about surface-atmosphere transport, and numerical models for investigation of problems related to heat and mass transfer in snow. These include two- and three-dimensional finite element programs for air flow with heat, water vapor, and chemical transport in porous media, as well as multidimensional models for diffusive transfer and natural convection.

Potential Users

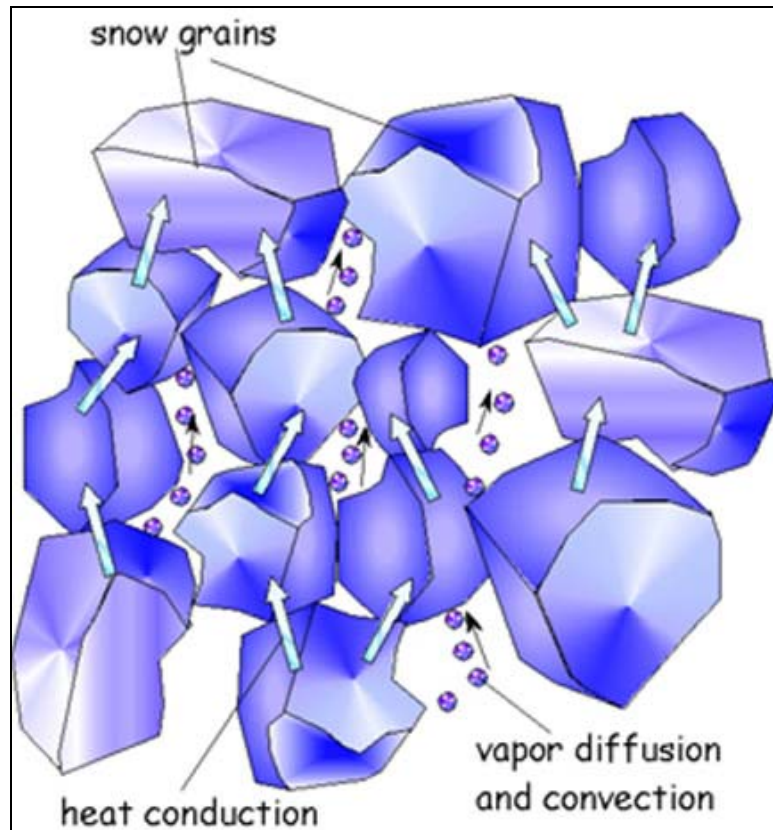
These findings regarding fundamental phenomena are relevant to many other types of porous media, and the snow and ice research community worldwide will benefit from this research as well.

Projected Benefits

ERDC-CRREL is one of the main centers of research related to heat and mass transfer in snow. Research highlights include the following:

- Complete survey of existing [thermal conductivity measurements](#) and the addition of several hundred new measurements
- Development of a snow classification system based on crystal growth mechanisms

- Development of one of the first detailed and complete layered snow heat and mass transfer models ([SNTHERM](#))
- Measurements and modeling of advective-diffusive heat transfer mechanisms and interstitial ventilation velocities in layered snow
 - First calculation of ventilation effects on snow sublimation
 - First tracer gas measurement of natural ventilation in naturally layered snow
- Recognition and quantification of thermal [convection](#) as a heat transfer mechanism in snow
- Establishment of accumulation rate as the cause for grain size, thermal conductivity, and permeability variations that are observable in satellite images in East Antarctica.



ERDC-CRREL researchers have recognized and quantified convection as a heat transfer mechanism in snow.

Program Manager

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